SAINTGITS
COLLEGE OF APPLIED SCIENCES

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Green audit

Dr. K. K. John
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SAINTGITS COLLEGE OF APPLIED SCIENCES * PATHAMUTTOM, KOTTAYAM *

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SAINTGITS
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Report

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GREEN AUDIT REPORT

SAINTGITS COLLEGE OF APPLIED SCIENCES

2021-22

Executed by

OTTOTRACTIONS
Energy-Engineering-Environment

OTTOTRACTIONS
Energy-Engineering-Environment
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ISO 9001-2015 & ISO 14001-2015 Certified

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GREEN AUDIT REPORT

SAINTGITS COLLEGE OF APPLIED SCIENCES

PATHAMUTTOM

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OTTOTRACTIONS
Energy-Engineering-Environment

Green Audit Report
Saintgits College of Applied Sciences, Pathamuttom
Report No: EA 973/GA
2022-December

About OTTOTRACTIONS

OTTOTRACTIONS established in 2005, is an organization with proven track record and knowledge in the field of energy, engineering, and environmental services. They are the first Accredited Energy Auditor from Kerala for conducting Mandatory Energy Audits in Designated Consumers as per Energy Conservation Act-2001. Government of Kerala recognized and appreciated OTTOTRACTIONS by presenting its prestigious "The Kerala State Energy Conservation Award 2009" for the best performance as an Energy Auditor. Ottotractions is an ISO 9001-2015 and ISO 14001-2015 Certified organization, which ensures the quality of its services.

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Acknowledgment

We were privileged to work together with the administration and staff of Saintgits College of Applied Sciences, Pathamuttom especially Dr K K John, Principal for their timely help extended to complete the audit and bringing out this report.

With gratitude, we acknowledge the diligent effort and commitments of all those who have helped to bring out this report.

We also take this opportunity to thank the bona-fide efforts of audit team for unstinted support in carrying out this audit.

We thank our consultants, engineers and backup staff for their dedication to bring this report.

Thank you.

B V Suresh Babu
Accredited Energy Auditor
AEA 33, Bureau of Energy Efficiency

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Preface

Educational institutions always had an important leadership role in society in demonstrating types of changes that used to occur with respect to the prime issues of the time. All around the world, educational institutions are taking steps to declare themselves the next carbon neutral school as a part of the global trend of becoming sustainable. In 2007, Victoria University School of Architecture and Design declared themselves the first carbon neutral campus in the world through the purchase of carbon credits. This concept is not a sustainable model as it does not guarantee the capture of carbon forever and also it is expensive.

The potential for any academic institution- (may be a school in a remote village or a university in an urban setting) - to become the driver for change is huge. Its role of practicing leadership in its community can be utilized to encourage and influence carbon neutral living.

The biggest factors that contribute towards emission are Energy, Transportation and Waste. Any reduction in the carbon emission by the above sectors, starts with the behavioral changes (Low cost) and/or technological investments (High cost). In order to make these changes, the students are to be educated properly on the concept of carbon neutral campuses and methods to reduce it.

In India, the concept of carbon neutral campuses is gaining momentum. Green Audit in Campuses measures the amount of Green House Gases (GHG) emissions produced as a result of its operations through an accounting like inventory of all the sources of GHGs and carbon sequestration in the school campus. Based on this, the total carbon footprint is estimated. Measures are recommended to bring down the carbon footprint of the campus and to make it a carbon neutral campus.

B Zachariah
Director, OTTOTRACTIONS

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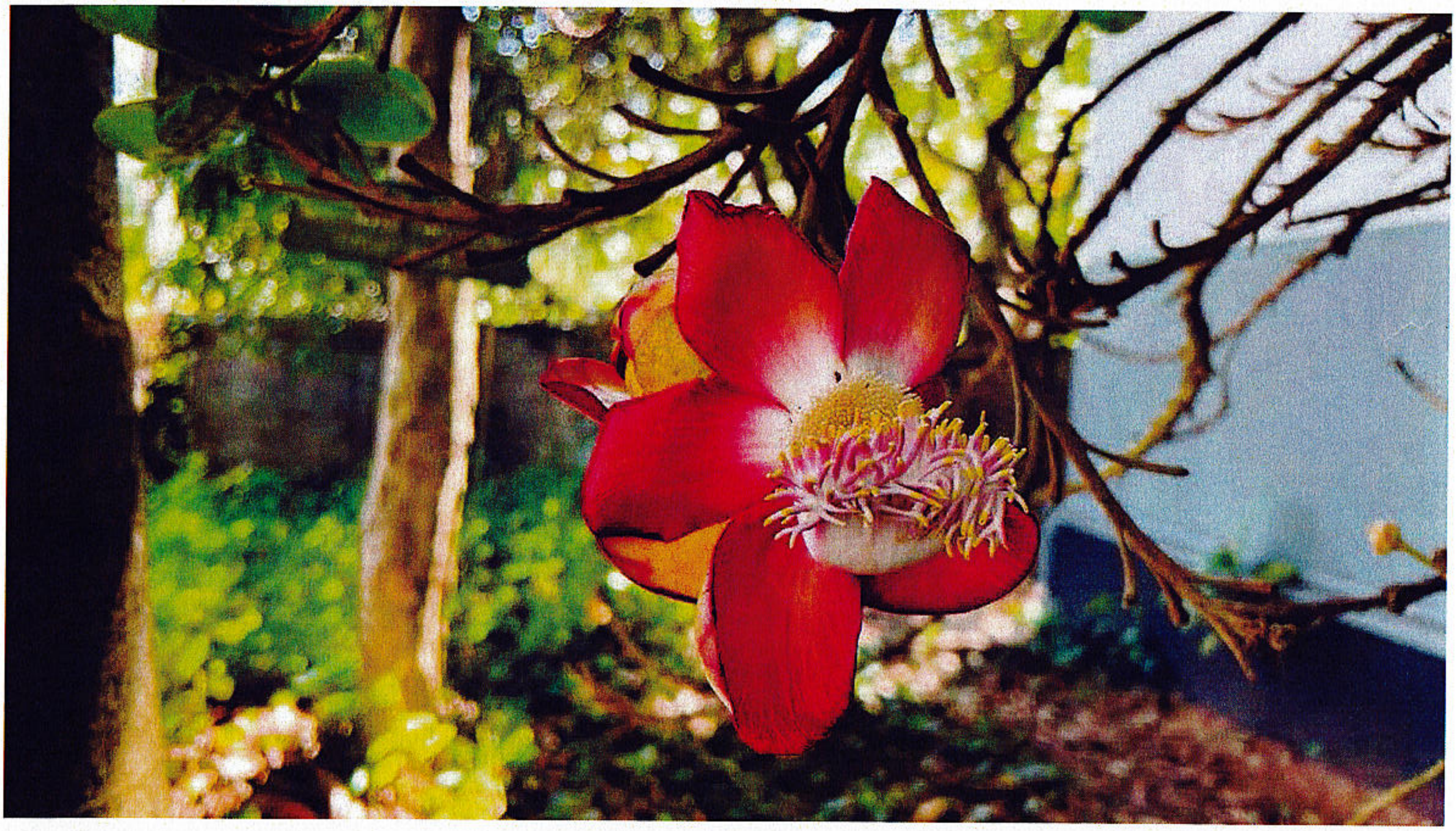
1 Introduction



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Background

All across the developed countries, educational institutions are now moving to a sustainable future by becoming carbon neutral and greener spaces. They are taking responsibility for their environmental impact and are working to neutralize those effects. To become carbon neutral, institutions are working to reduce their emissions of greenhouse gases, cut their use of energy, use energy efficient equipment, use more renewable energy, plant and protect green cover and emphasize the importance of sustainable energy sources. Institutions that have committed to becoming carbon neutral have recognized the threat of global warming and are therefore committing to reverse the trend. Studies on this line has not struck roots in most of the developing countries-especially among students.

The Sustainable Development Goals (SDGs), launched by the United Nations in 2015, are an excellent vehicle for driving this change. They represent an action plan for the planet and society to thrive by 2030. The SDGs provide a window of opportunity for creating multidimensional operational approaches for climate change adaptation. They address poverty, hunger and climate change, among other issues central to human progress and sustainable development, such as gender equality, clean water and sanitation, and responsible consumption and production.

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The Green Audit of **Saingits College of Applied Sciences, Pathamuttom** aims to assist campus to reduce their carbon footprint and educate tomorrow's leaders about strategies for carbon mitigation using their campus as a model. Also, this audit covers institutes responses towards SDGs by covering SDG 3,6,7,11,13,15. The green audit also aims to educate students and teachers on the concept of carbon footprint and to enable the students to collect data pertaining to the carbon emissions and carbon sequestration in their campus and to calculate the specific carbon footprint of the campus.

The project also suggests plans to make the campus carbon neutral or even carbon negative by implementing carbon mitigation strategies in areas such as,

a. Energy
b. Transportation
c. Waste minimisation
d. Carbon Sequestration etc.

The major objectives of the audit are:

- To make aware students and teachers on the concept of carbon footprint.
- To calculate the specific carbon footprint of the campus and classify it as carbon negative, neutral or positive.
- To create carbon mitigation plans to reduce their footprint based on the data generated.

SAINTGITS COLLEGE OF APPLIED SCIENCES,

Saintgits College of Applied Sciences is a new generation Arts and Science college launched in 2004. It has maintained high standards in academic as well as extra-curricular activities ever since it launched with a full capacity of students. With a scientifically planned teaching methodology, combined with some of the best and experienced faculty and state-of-the-art infrastructure, the institute has set a benchmark in graduate studies.

In addition to the syllabus, the institution always caters to the all-round growth of the youth and with this objective in mind we offer value-added programmes. This

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institution is well known for campus placement and ensures higher education in esteemed national and international universities and institutes.

Occupancy Details	
Particulars	2021-22
Total Students	1000
Staffs	54
Total Occupancy of the college	1054

For calculating per capita carbon emission estimation, only the student strength is taken into account.

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Form-A

BASELINE DATA SHEET FOR GREEN AUDIT

1	Name of the Organisation	Saintgits College of Applied Sciences, Pathamuttom					
2	Address (include telephone, fax & e-mail)	Kottukulam Hills, Pathamuttom P.O, Kottayam, Pin – 686532, Kerala Tel:+91 481 2433787, +91 9544327772, Email: scas@saintgits.org					
2	Year of Establishment	2004					
3	Name of building and Total No. of Electrical Connections/building	Old Building, Deceinial block					
4	Total Number of Students	Boys		Girls		Total	1000
5	Total Number of Staff	54					
6	Total Occupancy	1054					
7	Total area of green cover	50%					
8	Type of Electrical Connection	HT	1	LT	-		
9	Total Connected Load (kW)	88					
10	Average Maximum Demand (KVA)	43					
11	Total built up area of the building (M^2)	7400					
12	Number of Buildings	1					
13	Average system Power Factor	0.83					
14	Details of capacitors connected	NA					
15	Transformer Details (Nos., kVA, Voltage ratio)	TR 1					
15	DG Set Details (kVA,)	DG1	DG2	DG3	DG4	DG5	Remarks
		30					
16	Details of motors	Rating	Nos.	Remarks			
		5 to 10	3				
		10 to 50					
		Above 50					
17	Brief write-up about the firm and the energy/environmental conservation activities already undertaken.	Installed LED Bulbs, Solar power plant etc.					
18	Contact Person & Telephone number	Principal					
		Tel:+91 481 2433787, +91 9544327772,					

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2

METHODOLOGY

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2.1. Sensitisation

Low Carbon campus initiatives are successful when everyone in the campus is engaged including students, teachers and staff. A team of students, teachers and staff were formed to participate in the audit. A sensitisation among students and teachers on the concept of carbon footprint was conducted.

During the audit the students and staffs were sensitised on the project and trained to be a part of the data collection team. This helped in conducting the survey in a participatory mode so that the awareness will penetrate to the grass root level. During the data collection field visit it was stressed that the team will spread these ideas to their homes and friends. This will help in a horizontal and vertical spread of the message to a wider group. It is assumed that through 1054 occupants of this campuses will reach same number of households. This message will spread to at least 4000 individuals approximately.

2.2 Estimation of carbon footprint

A carbon footprint is the amount of greenhouse gases—primarily carbon dioxide—released into the atmosphere by a particular human activity. A carbon footprint can be a broad measure or be applied to the actions of an individual, a family, an event, an organization, or even entire nation. It is usually measured as tons of CO_2 emitted per year, a number that can be supplemented by tons of CO_2-equivalent gases, including methane, nitrous oxide, and other greenhouse gases.

Global Warming Potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to carbon dioxide. The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of one ton of a gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide (CO_2).

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Global Warming Potentials (IPCC Second Assessment Report)					
Species	Chemical formula	Lifetime (years)	Global Warming		
			20 years	100 years	500 years
Carbon dioxide	CO2	variable §	1	1	1
Methane *	CH4	12±3	56	21	6.5
Nitrous oxide	N2O	120	280	310	170
HFC-23	CHF3	264	9100	11700	9800
HFC-32	CH2F2	5.6	2100	650	200
HFC-41	CH3F	3.7	490	150	45
HFC-43-10mee	C5H2F10	17.1	3000	1300	400
HFC-125	C2HF5	32.6	4600	2800	920
HFC-134	C2H2F4	10.6	2900	1000	310
HFC-134a	CH2FCF3	14.6	3400	1300	420
HFC-152a	C2H4F2	1.5	460	140	42
HFC-143	C2H3F3	3.8	1000	300	94
HFC-143a	C2H3F3	48.3	5000	3800	1400
HFC-227ea	C3HF7	36.5	4300	2900	950
HFC-236fa	C3H2F6	209	5100	6300	4700
HFC-245ca	C3H3F5	6.6	1800	560	170
Sulphur hexafluoride	SF6	3200	16300	23900	34900
Perfluoromethane	CF4	50000	4400	6500	10000
Perfluoroethane	C2F6	10000	6200	9200	14000
Perfluoropropane	C3F8	2600	4800	7000	10100
Perfluorobutane	C4F10	2600	4800	7000	10100
Perfluorocyclobutane	c-C4F8	3200	6000	8700	12700
Perfluoropentane	C5F12	4100	5100	7500	11000
Perfluorohexane	C6F14	3200	5000	7400	10700

The methodology for carbon footprint calculations are still evolving and it is emerging as an important tool for green house management. In the present study carbon emission data from the campus is estimated under four categories viz.

a. Energy
b. Transportation
c. Waste minimisation
d. Carbon Sequestration

Carbon neutrality refers to achieving net zero GHG emission by balancing the measured amount of carbon released into atmosphere due to human activities, with an equal amount sequestrated in carbon sinks. It is crucial to restrict atmospheric concentrations of GHGs released from various socio-economic, developmental and life style activities using biological or natural processes. It is recognized that addressing climate change is not as simple as switching to renewable energy or offsetting GHG emissions. Rather, providing an opportunity

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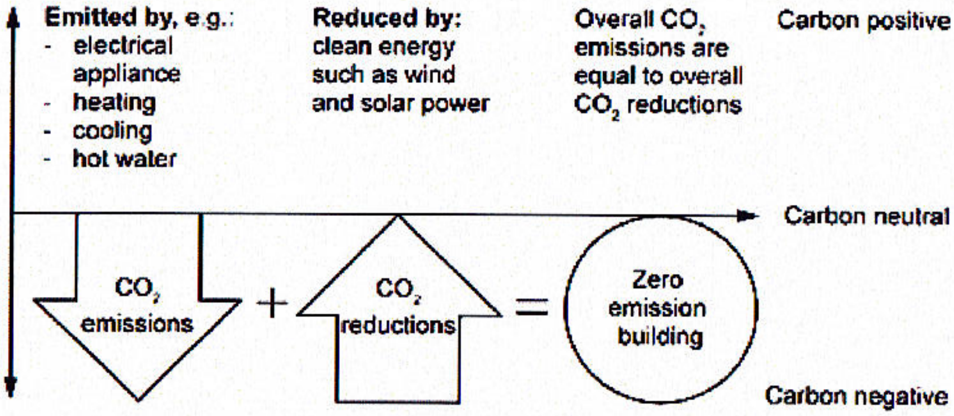
for innovation in new developmental activities for viable and effective approach to address the problem.



Energy

In the campus carbon emission from energy consumption is categorised under two headings viz. energy from Electrical and Thermal. Energy used for transportation is calculated under transportation sector.

A detailed energy audit is conducted to understand the energy consumption of the campus. Information on total connected loads, their duration of usage and documents like electricity bills are evaluated. Connected loads are calculated by conducting a survey on electrical equipment on each location. Duration of usage was found out by surveying the users. The survey of equipment was conducted in a participatory mode.

The fuel consumption for cooking, like LPG, was studied by analysing the annual fuel bills and usage schedules during the study. Discussions were carried out with the concerned individuals who actually operate the cooking system.

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Transportation

Carbon emission from transportation to be calculated by using the following formula:

Carbon Emission = Number of each type of vehicles × Avg. fuel consumed per year × Emission factors (based on the fuel used by the vehicle)

Waste Minimisation

The waste generated from the campus is also responsible for the greenhouse gas emission. So, in order to calculate the total carbon foot print of the campus it is necessary to estimate the greenhouse gas emission from the waste generated in the campus by the activity of the students, teachers and staffs.

The calculation of the waste generated has been conducted by keeping measuring buckets for collecting the waste generated in a day. This waste so generated was calculated by weighing it.

Carbon Sequestration

Carbon sequestration is the process involved in the long-term storage of atmospheric carbon dioxide. Trees remove carbon dioxide from the atmosphere through the natural process of photosynthesis and store the carbon in their leaves, branches, stems, bark, and roots.

Carbon sequestrated by a tree can be found out by using different methods. Since this study is employed the volumetric approach, the calculation consists of five processes.

- Determining the total weight of the tree
- Determining the dry weight of the tree
- Determining the weight of carbon in the tree
- Determining the weight of CO_2 sequestrated in the tree

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- Determining the weight of CO_2 sequestrated in the tree per year

Detailed calculations and results are given in the technical supplements of this document.

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3

RESULTS AND DISCUSSIONS

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3.1 CARBON FOOTPRINT ESTIMATION

3.1.1 ENERGY

a. Electricity

Electricity is purchased from KSEB under HT Connections, the details are given below.

Base line Data (Electricity Bill)	
Code	EA 973
Facility	Saintgits College of Applied Sciences
Provider	KSEB
Contract Demand (kVA)	80
Connected Load (KW)	88
Tariff	HT II (B) GENERAL
Consumer Number	1346370050721
Energy Charge Rs/ kWh Z1	6.2
Energy Charge Rs/ kWh Z2	9.3
Energy Charge Rs/ kWh Z3	4.65
Demand Charge Rs/ kVA	440
Excess Demand Rs/kVA	220
Energy Bill Analysis interval	2021-22

Electricity Bill Analysis

Electricity Bill Details (2021-22)												
Month	Name of the Consumer				Saintgits College of Applied Sciences							
	Contract Demand(kVA)		80		Consumer number & Section			1346370050721				
	Tariff		HT II (B) GENERAL					Vakathanam				
	kWh				kVA			PF	PF Incentive	PF Penalty	Rs (Total)	Rs/kwh
	Z1	Z2	Z3	Total	Z1	Z2	Z3					
Apr	4367	379	1080	5826	34	5	18	0.99	0	0	65555	**11.25**
May	2633	368	787	3788	31	5	15	0.99	0	0	53056	**14.01**
Jun	1529	325	633	2487	23	5	9	0.76	0	2548	46001	**18.50**
Jul	2190	361	670	3221	25	6	11	0.69	0	4711	53761	**16.69**
Aug	3100	390	779	4269	29	7	11	0.75		4632	60255	**14.11**
Sep	3191	411	807	4409	32	7	12	0.78		3967	60572	**13.74**
Oct	3201	395	729	4325	30	6	12	0.77		4170	60279	**13.94**
Nov	3465	396	787	4648	34	6	15	0.81		3314	61367	**13.20**
Dec	5312	391	867	6570	43	6	22	0.85		3045	74332	**11.31**
Jan	5306	560	1049	6915	41	21	22	0.87		2364	76218	**11.02**
Feb	4826	421	1043	6290	42	7	22	0.85		2901	72013	**11.45**
Mar	4750	365	853	5968	40	7	22	0.87		2024	68862	**11.54**
				58716	43			0.8317			752271	**13.40**

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Diesel

Diesel Consumption Details				
	Transportation	Generator	Total	cost
	in L	in L	in L	in Rs
21-22	5091	595	5687	540228

Base Line Energy Data		
Saintgits College of Applied Sciences, Pathamuttom		
		2021-22
1	Electricity KSEB (kWh)	58716
2	Electricity Solar - Off grid (kWh)	0.00
3	Electricity (KSEB + Off grid) kWh	58716
4	Electricity Grid Tied (kWh)	6388
5	Diesel (L)	5687
6	LPG (kg)	0.00
7	Biogas (m3)	0.00

Renewable Energy

Solar Power Plant

Capacity (kWp)	Annual Generation (kWh)
5	6388

A solar power plant is installed (5kWp) .

Specific Energy Consumption

Saintgits College of Applied Sciences, Pathamuttom		
Energy Performance Index (EPI)		
Sl No	Particulars	2021-22
1	Total building area (m²)	7400
2	Annual Energy Consumption (kCal)	110205139
3	Annual Energy Consumption (kWh)	128146
4	Total Energy in Toe	11.02
5	Specific Energy Consumption kWh/m²	17.32

The specific energy consumption in 2021-22 may be taken as benchmark.

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3.3. Waste Generation total

The major concern of waste management will be focused on the solid waste produced by the campus. Solid wastes produced in the campus are mainly of three types, food waste, paper waste, and plastic waste. Food wastes produced in the campus are mainly by two means. The vegetable wastes produced in the kitchen during the food preparation. The food waste produced by the students and staffs of the campus after the consumption of meals.

Degradable Waste

Degradable Waste Generation	
Saintgits College of Applied Sciences, Pathamuttom	
Particulars	2021-22
Total Occupancy	1054
Waste generated in kg /day	21.08
Waste generated in kg /Yr	4637.6

Non-Degradable waste

Solid non degradable Waste Generation	
Saintgits College of Applied Sciences, Pathamuttom	
Particulars	2021-22
Total Occupancy	1054
Waste paper generated in kg /day	0.2108
Waste plastic generated in kg /day	0.3162
Waste paper generated in kg /Yr	46.38
Waste plastic generated in kg /Yr	69.56

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3.4. Transportation

There are 6 numbers of buses and 3 cars for the public transportation available at the college.

Carbon Emission Profile (2021-22)

Carbon emissions in the campus due to the day-to-day activities are calculated and is discussed below. The emission factors considered for estimation and its units are given.

Emission Factors		
Item	Factor	Unit
Electricity	0.000782	tCo_2e/kWh
LPG	0.0015	tCo_2e/kg
Diesel	0.0032	tCo_2e/kg
Petrol	0.0031	tCo_2e/kg
Food Waste	0.00063	tCo_2e/kg
Paper Waste	0.00056	tCo_2e/kg
Plastic Waste	0.00034	tCo_2e/kg

Carbon Foot Print 2021-22

Carbon Foot Print			
Sl. No.	Particulars	2021-22	tCO2e
1	Electricity (kWh)	58716	48.15
2	Diesel (L)	5687	18.20
3	LPG (kg)	0.00	0.00
4	Biogas (m3)	0.00	0.00
5	Degradable Waste in kg/yr.	4637.6	2.92
6	Paper Waste in kg/yr	46.38	0.03
Total Carbon Foot Print tCO2e/yr			69.29

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3.5. CARBON SEQUESTRATION

All the activities including energy consumption and waste management have their equivalent carbon emission and they positively contribute to the carbon footprint of the campus. Carbon sequestration is the reverse process, at which the emitted carbon dioxide will get sequestrated according to the type of carbon sequestration employed. Even though there are many natural sequestration processes are involved in a campus, the major type of sequestration among them is the carbon sequestration by trees.

Particulars	2021-22
Total number of trees	1893
Carbon sequestrated by trees in the campus (tCO2e)	6.27

Trees sequestrate carbon dioxide through the biochemical process of photosynthesis and it is stored as carbon in their trunk, branches, leaves and roots. The amount of carbon sequestrated by a tree can be calculated by different methods. In this study, the volumetric approach was taken into account, thus the details including CBH (Circumference at Breast Height), height, average age, and total number of the trees, are required. Details of the trees in the campus compound are given in the Table. Detailed table is included in the technical supplement.

Carbon sequestrated by a tree can be found out by using different methods. Since this study is employed the volumetric approach, the calculation consists of five processes.

- Determining the total weight of the tree
- Determining the dry weight of the tree
- Determining the weight of carbon in the tree
- Determining the weight of CO_2 sequestrated in the tree
- Determining the weight of CO_2 sequestrated in the tree per year

Carbon sequestrated by each species of trees in the campus compound is given in the Table.3.19 Detailed calculation results are listed out in the tables provided in the technical supplements of 'Carbon sequestration'.

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List of Trees in Campus

Name of the plant	Family	number
1. Strychnos nux-vomica	Loganiaceae	1
2. Emblica officinalis	Euphorbiaceae	1
3. Ficus racemosa	Moraceae	2
4. Syzygium cumini	Myrtaceae	1
5. Acacia catechu	Mimosae	1
6. Diospyros ebenum	Ebenaceae	1
7. Bambusa bambos	Poaceae	1
8. Ficus religiosa	Moraceae	1
9. Mesua ferrea	Callophyllaceae	1
10. Ficus benghalensis	Moraceae	1
11. Butea monosperma	Leguminosae	1
12. Ficus tinctoria	Moraceae	1
13. Spondias pinnata	Anacardiaceae	1
14. Aegle marmelos	Rutaceae	1
15. Terminalia arjuna	Combretaceae	1
16. Flacourtia jangomas	Salicaceae	1
17. Mimusops elengi	Sapotaceae	1
18. Aporusa lindleyana	Euphorbiaceae	1
19. Vateria indica	Dipterocarpaceae	1
20. Salix tetrasperma	Salicaceae	1
21. Atrocarpus heterophyllus	Euphorbiaceae	1
22. Calotropis gigantea	Apocynaceae	2
23. Prosopis juliflora	Leguminosae	1
24. Anthocephalus cadamba	Rubiaceae	1
25. Mangifera indica	Ancardiaceae	2
26. Borassus flabellifer	Palmae	1
27. Madhuca longifolia	Sapotaceae	1
28. Aloe vera	Liliaceae	8
29. Spathodea campanulata	Bignonaceae	1
30. Occinum sanctum	Lamiaceae	10
31. Andrographis paniculata	Acanthaceae	5
32. Catharanthus roseus	Apocynaceae	6
33. Guazuma tomentosa	Sterculiaceae	1
34. Dracaena godseffiana	Liliaceae	2
35. Tabernaemontana divaricata	Apocyananceae	1
36. Torenia fournieri	Scrophulariaceae	3
37. Zamia furfuracea	Zamiaceae	1
38. Piper longum	Piperaceae	4
39. Spathoglottis plicata	Orchidaceae	30
40. Spathiphyllum wallisii	Araceae	1

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41. Mirabilis jalapa	Nyctaginaceae	6
42. Saraca indica	Leguminosae	1
43. Russelia equisetifolia	Sacrophulariaceae	1
44. Rosa indica	Rosaceae	10
45. Pseuderanthemum carruthersii	Acanthaceae	1
46. Portulaca grandiflora	Protulacaceae	19
47. Polyscias guilfoylii	Araliaceae	1
48. Plumeria obtusa	Apocynaceae	1
49. Nymphaea caerulea	Nymphaeaceae	3
50. Nerium oleander	Apocynaceae	2
51. Nephilium lappacaeum	Sapindaceae	1
52. Muehlenbeckia platyclados	Polygonaceae	1
53. Episcia cupreata	Gesneriaceae	19
54. Dracaena fragrans	Liliaceae	12
55. Dieffenbehia maculata	Araceae	2
56. Cyrtostachys renda	Arecaceae	10
57. Cycas revoluta	Cycadaceae	4
58. Costus malortieanus	Zingiberaceae	36
59. Chrysalidocarpus lutescens	Arecaceae	2
60. Chlorophytum laxum	Lilaceae	17
61. Bougainvillea spectabilis	Nyctaginaceae	5
62. Begonia erythrophylla	Begoniaceae	2
63. Begonia corallina	Begoniaceae	2
64. Bambusa vulgaris	Poaceae	61
65. Bambusa heterostachya	Poaceae	22
66. Michelia champaca	Nyctaginaceae	1
67. Malaviscus arboreus	Magnoliaceae	3
68. Licuala peltata	Arecaceae	4
69. Adenium obesum	Apocynaceae	24
70. Aglaonema commutatum	Araceae	8
71. Lantana camara	Verbenaceae	30
72. Hemigraphis alternata	Acanthaceae	179
73. Hamelia patens	Rubiaceae	1
74. Excoecaria bicolor	Euphorbiaceae	3
75. Euphorbia tirucalli	Euphorbiaceae	1
76. Euphorbia milii	Euphorbiaceae	30
77. Anthurium andreanum	Araceae	56
78. Ananus nanus	Bromeliaceae	4
79. Allamanda catharitica	Apocynaceae	9
80. Aglaonema crispum	Araceae	7

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81. Aglaonema costatum	Araceae	4
82. Michelia jalapa	Magnoliaceae	1
83. Begonia heracleifolia	Begnoniaceae	4
84. Clerodendrum thomsoniae	Lamiaceae	13
85. Simmarouba glauca	Simaroubaceae	1
86. Hibiscus rosa-sinensis	Malvaceae	4
87. Euphorbia hirta	Euphorbiaceae	11
88. Vitex negundo	Lamiaceae	1
89. Citrus aurantifolia	Rutaceae	3
90. Centella asiatica	Apiaceae	206
91. Murraya exotica	Rutaceae	2
92. Persea americana	Lauraceae	1
93. Psilotum nudum	Psilotaceae	37
94. Piper beetle	Piperacae	1
95. Pimenta dioica	Myrtaceae	1
96. Selaginella willdenowii	Selaginellaceae	3
97. Adiantum pedatum	Pteridaceae	4
98. Gleichenia linearis	Fabaceaea	1
99. Pteris vittata	Pteridaceae	15
100. Melastoma malabathricum	Melastomaceae	1
101. Vernonia elaeagnifolia	Asteraceae	4
102. Canna indica	Scitaminae	4
103. Oxalis corniculata	Oxalidaceae	400
104. Biyophytum sensitivum	Oxalidaceae	200
105. Pandanus tectorius	Pandanaceae	1
106. Sterliztia reginae	Scitamineae	42
107. Tylophora indica	Asclepiadaceae	1
108. Phyllanthus niruri	Phyllanthaceae	56
109. Plumeria rubra	Apocynaceae	1
110. Justicia adhatoda	Acanthaceae	2
111. Ficus microcarpa	Moraceae	1
112. Azadirachta indica	Meliaceae	1
113. Annona muricata	Annoniaceae	1
114. Permna seratifolia	Lamiaceae	2
115. Thunbergia grandiflora	Acanthaceae	1
116. Flacourtia indica	Salicaceae	1
117. Pteris creticum	Apocynaceae	1
118. Pteris verigata	Apocynaceae	1
119. Carica papaya	Caricaceae	3
120. Asparagus racemosus	Liliaceae	4
121. Ixora maui	Rubiaceae	8
122. Muntingia calabura	Teliaceae	1
123. Dendrobium spp	Orchidaceae	84

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124. Callistemon viminalis	Myrtaceae	1
125.Celastrus paniculatus	Celestraceae	2
126. Adenocalymma obovatum	Bignoniaceae	3
127. Polyscias guilfoylei	Araliaceae	5
128. Sansevieria trifasciata	Liliaceae	1
129. Cordyline terminalis	Liliaceae	4
130. Codiaeum variegatum	Euphorbiaceae	8
131. Tecomaria carpensis	Bignoniaceae	4
134. Justicia jendarussa	Acanthaceae	5
135. Asparagus aethiopicus	Liliaceae	3
136. Schefflera actinophylla	Araliaceae	4
137. Loropetalum chinense	Scrophulariaceae	7
138. Pachystachis coccinea	Acanthaceae	3
139. Schefflera arboricola	Araliaceae	3
140. Maranta variegata	Marantaceae	2
		1893

CARBON FOOTPRINT OF THE CAMPUS (2021-22)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **69.29 tCO_2e** per year by the campus. The total carbon sequestration by trees in the campus compound is **6.68tCO2e**. Thus, the current carbon footprint of the campus will be the difference of total carbon emission and total carbon sequestration/mitigation. The following table shows the carbon footprint level

Specific CO2 Footprint

Amount of Carbon to be mitigated for Low Carbon Campus		
Sl No	Particulars	2021-22
1	Total carbon emission tCO2e	69.29
2	Total carbon sequestration tCO2e	6.68
3	Amount of carbon mitigated through renewable energy tCO2e	5.24
4	To be mitigated tCO2e	57.38
5	Total No of Students	1000
6	Specific Carbon Footprint kg CO2e/Student/Yr	57.38

The total specific carbon emission is estimated as **57.38** kg of CO_2e per student for the year 2021-22.

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Carbon Mitigation Plans

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The total emission of the carbon dioxide per student is **69.29** kg per year (2021-2022). Emission reduction plans were prepared to bring the existing per capita carbon footprint to zero or below so as to bring the campus a carbon neutral or carbon negative campus.

This can be achieved in many ways but, every alternate plan must be in such a way that, it must fulfill the actual purpose of each activity that is considered.

Here, three major methods are taken in to account as the plans for reducing the carbon emission of the campus.

- Resource optimisation
- Energy efficiency
- Renewable energy

RESOURCE OPTIMISATION

The effective use of resources can limit its unnecessary wastage. Optimal usage of the resources (such as fuels) can save the fuel and can also reduce the carbon emission due to its consumption. This technique can be effectively implemented in the 'transportation' and 'waste' sectors of the campus.

WASTE MINIMISATION

Optimal utilisation of paper and plastic stationaries can reduce the frequency of purchase of items. This can reduce the unnecessary wastage of money as well as the excess production of waste. In the case of food, proper food habits and housekeeping practices can optimise its usage.
Currently, the campus is taking an appreciable effort to reduce the unnecessary production of wastes. But the campus still has opportunities to reduce the generation of waste and can improve much more. Resource optimisation can be effectively implemented in all type of waste generated in the campus and the campus can expect about 50% reduction the total waste produced.

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ENERGY EFFICIENCY

Energy efficiency is the practice of reducing the energy requirements while achieving the required energy output. Energy efficiency can be effectively implemented in all the sectors of the campus.

FUELS FOR COOKING

The campus uses commercial LPG cylinders for its cooking purpose. The campus can install a biogas plant to treat food waste and the biogas thus generated can be used in kitchen. Installation of a solar water heater to rise the water temperature to a much higher level, then it has to consume only very less amount of thermal energy for preparing the same amount of food is another method. This can make a positive benefit to the campus by saving money, energy and can reduce the carbon emission of the campus due to thermal energy consumed for cooking.

TRANSPORTATION

Energy efficiency of the transportation sector is mainly depended on the fuel efficiency of the vehicles used. Here mileage of the vehicle (kmpl - Kilometres per Litre) is calculated to assess the fuel efficiency of the vehicle.

Percentage of closeness is the ratio of actual mileage of the vehicle to its expected mileage. If the percentage of closeness of mileages of each vehicle is greater than that of its average, then the efficiency status of the vehicle is considered as 'Above average' and else, it is considered as 'Below average'.

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Carbon Mitigation Proposals

After analyzing the historical and measured data the following projects are proposed to make the campus carbon neutral. The projects are from energy efficiency and renewable energy. The further additions in the green cover increase will also give positive impact in the carbon mitigation.

OTTOTRACTIONS- ENERGY AUDIT						
Saintgits College of Applied Sciences, Pathamuttom						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO2 mitigated	Expected Tons of CO2 mitigated through out life cycle
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 257 No's T12 (55W) Lamps to 18W LED Tube	6819	6.82	10	4.98	49.78
2	Energy Saving by replacing existing 260 No's in-efficent ceiling fans with Energy Efficient Five star fans	9784	9.78	10	7.14	71.43
Total		**16603**	**17**	**10**	**12.12**	**121.20**

OTTOTRACTIONS- ENERGY AUDIT						
Saintgits College of Applied Sciences, Pathamuttom						
Greenhouse Gas Mitigation through Renewable Energy Projects						
Sl No	Projects	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO2 mitigated	Expected Tons of CO2 mitigated through out life cycle
		(kWh)	MWh	Years		
1	Installation of 50kWp Solar Power Plant	63875	63.88	25	46.63	1165.72
	Total	63875	64	25	47	1166

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OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal Code	
Energy Saving in Lighting by replacing existing 257 No's T12 (55W) Lamps to 18W LED Tube	
Existing Scenario	
257 numbers of T12(55 W) lamps were identified during the energy audit field survey in the facility. During discussion with officers it is observed that the average utility of these fittings are of 30%.	
Proposed System	
The existing T12 may be replaced to LED Tube of 18W in phased manner and the savings will be of 67% (inclusive of improved light output and reduced energy consumption)	
Financial Analysis	
Annual working hours (hr)	2400
No of fittings	257
Total load (kW)	14.14
Annual Energy Consumption (kWh)	10177
Expected Annual Energy saving for replacing all fittings (kWh)	6819
Cost of Power	13.39
Annual saving in Lakhs Rs (1st year)	0.91
Investment required for complete replacements [@Rs 300 per fittings](Lakhs Rs)	0.77
Simple Pay Back (in Months)	10.13

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OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving by replacing existing 260 No's in-efficient ceiling fans with Energy Efficient Five star fans	
Existing Scenario	
There are 260 numbers of ceiling fans installed in the facilty with minimum 8 hrs a day operation. All are conventional type and most of them are very old.	
Proposed System	
There is an energy saving opportunity in replace the existing fans with new five star labelled fans.The five star labelled fans give a savings up to 30% with higher service value (air delivery/watt).	
Financial Analysis	
Annual working hours (hrs)	2400
Total numbers of ordinary fans	260
Total load (kW)	18.20
Annual Energy Consumption (kWh)	34944
Expected Annual Energy saving, for total replacement(kWh)	9784
Cost of Power (Rs)	13.39
Annual saving in Lakhs Rs (1st year)	1.31
Investment required for a total replacement (Lakhs Rs)[@3000 Rs per Fan with 50W at full speed]	7.80
Simple Pay Back (in Months)	71.44

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Energy Saving Proposal	
Installation of 50kWp Solar Power Plant	
Existing Scenario	
There is a good potential of solar power electricity generation. The availability of sunlight is very high. There are some canopies available in the proposed site, but by having proper trimming of trees this may be avoided. If the SPVs are place in the roof top it will help improving RTTV (Roof Thermal Transmit Value) of the building.	
Proposed System	
It is proposed to have a Solar Power Plant of 50kW at the beginning stage. The state and central government is pushing and giving good assistance to the installation. It can be installed as an internal grid connected system which is much cheaper than off grid system. Now days the technology provides trouble free grid interactive and connected system. The installation will provide 25yrs trouble free generation with only 20% efficiency loss at the 25th year.	
Financial Analysis	
Proposed Solar installed Capacity (kW)	50
Total average kWh per day expected (3.5kWh/day average)	175.00
Total annual Generating Capacity (kWh)	63875
Cost of energy generated annually Lakhs Rs	8.50
Investment required (INR lakh)(Approx)	27.50
Simple Pay Back (in Months)	38.84
Life cycle in Yrs	25
Total Saving in Life Cycle (Approx) RS lakh	212.38

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Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
Saintgits College of Applied Sciences, Pathamuttom					
Sl No	Projects	Investment	Cost saving	SPB	Energy saved
		(Lakhs Rs)	(Rs)/Yr	Months	kWh/Yr
1	Energy Saving in Lighting by replacing existing 257 No's T12 (55W) Lamps to 18W LED Tube	0.77	0.913	10.13	6819
2	Energy Saving by replacing existing 260 No's in-efficent ceiling fans with Energy Efficient Five star fans	7.80	1.310	71.44	9784
3	Installation of 50kWp Solar Power Plant	27.50	8.50	38.84	63875
	Total	**8.57**	**2.22**	**81.58**	**16603.04**
(The saving are projected as per the assumed operation time observed based in the discussions with the plant officials. The data of saving percentages are taken from BEE guide books and field measurements.)					

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CONCLUSION

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The carbon emission from different sectors namely, Energy, Transportation and wastes were calculated using standard procedures. Carbon sequestration by the trees present in the campus was also estimated. From these the total carbon footprint of the campus was arrived at.

Net Carbon Emission after implementing Energy Efficiency projects and Renewable Energy Projects Proposed		
1	Total Carbon Foot Print tCO_2e/yr	69.29
2	Carbon Sequestrated tCO_2e/yr	6.68
3	Carbon mitigated by Renewable Energy tCO_2e/yr (Installed)	5.24
4	Carbon mitigated by Renewable Energy tCO_2e/yr (Proposed)	46.63
5	Carbon mitigated by Energy Efficiency (Proposed) tCO_2e/yr	12.12
6	Effective Carbon footprint tCO_2e/yr	-1.37
7	Total No of Students	1000
8	Specific Carbon Footprint kg CO_2e/Student/Yr	-1.37

From this study it was found that carbon footprint of the campus to be **-18.46** $kgCO_2e$/ Student/ Year in place of current footprint i.e., **69.69** $kgCO_2e$/ student/ Year. This will be achieved after implementing energy efficiency projects and implementation of 50kWp solar power plant. To achieve this an investment of **36.07 lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **3607 Rs per student** to make the campus the carbon negative.

Cost to make the campus Carbon Negative		
1	Cost of implementation in Energy Efficiency Lakhs Rs	8.57
2	Cost of implementation in Renewable Energy Lakhs Rs	27.50
3	Total Lakhs Rs	36.07
4	Total number of students	1000
5	Cost per student to make the campus carbon negative Rs/ Student	3607

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OTTOTRACTIONS
Energy Engineering Environment

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OTTOTRACTIONS
Energy-Engineering-Environment

6

TECHNICAL SUPPLEMENT

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Sl No		Light								FAN			AC		
		T12	T8	T5	CFL	ICL	LEDT	LEDB	LED (40w)	CF	EF	WF	2TR	1.5TR	1TR
1	Old building	198					77			157			9		
2	Deceinial block	59					127			103				3	1
	Total	257	0	0	0	0	204	0	0	260	0	0	9	3	1
	Wattage	55	40	28	30	100	18	30	40	80	60	55	2000	500	4000
	Power	14.14	0	0	0	0	3.67	0	0	21	0	0	18	1.5	4

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